Blakesley has given a simple geometrical means of designing a thin lens to comply with these conditions. Of course, spherical aberration is not the only, or even the most important defect of a lens; but the simplicity of the geometrical construction leads one to wish that expert mathematicians would devote some attention to the subject to see whether graphical methods could not be used in other cases.

Central and eccentric oblique refractions are discussed in chapters v. and vi. respectively. Eccentric oblique refraction is answerable for the phenomenon of "coma" or "side flare," which is discussed in great detail in chapters viii. and viii*a*. It would be impossible, in the short space of an article such as the present, to deal with the author's treatment of this interesting subject in detail; it must suffice to say that it has now for the first time been brought within the reach of any reader possessing ordinary mathematical attainments who will devote the necessary time and attention to the subject. Some of Mr. Taylor's results are similar to those obtained by Von Siedel, but many are novel. The most important advance effected by Mr. Taylor is the investigation of the foci of oblique and eccentric pencils of large aperture.

The distortion of the image formed by a system of lenses is very fully investigated in chapter ix., where it is shown that Coddington's method is defective in not carrying the spherical aberration of the first lens through to all succeeding lenses, a considerable error being thus introduced. The distortion produced by several combinations of lenses is worked out numerically, and it is shown that, in the case of an eye-piece of a telescope or microscope, an image which is really distorted *may* appear to be undistorted, owing to a peculiarity of the eye. Achromatism is dealt with in chapter x. In reading this, and, indeed, most other chapters of the book, one cannot help being struck by the care with which the author has experimentally tested the results obtained, sometimes finding that an extension of the theory is necessary (see, for example, p. 309). A brief sketch of the errors of the third order is given in chapter xi.

On closing Mr. Taylor's book, we are left to reflect on the living interest which he has given to mathematical investigations, essentially of a somewhat clumsy nature. Throughout the book, theory and practice go hand in hand, and we feel that the labour of solving the complicated problems which arise is well worth the while, for something tangible and useful is gained in the end. It would be well if the examining bodies of the various universities were to attach greater importance to geometrical optics, *studied from an essentially practical point of view.* At present the startling discoveries which have been made during recent years in other branches of physics absorb so much attention that many students who sit for advanced examinations in physics are culpably ignorant as to even fundamental properties of lenses. Questions on geometrical optics are rarely set by examiners; and when they are, they are too often merely mathematical exercises. Since accurate experimenting so often involves the use of lenses and other optical appliances, this state of things is greatly to be regretted.

EDWIN EDSER.

A THEORY OF THE ÆTHER.

Prof. H. M. Macdonald

Æther: A Theory of the Nature of Æther and of its Place in the Universe. By Dr. Hugh Woods. Pp. xii + 100. (London: *The Electrician* Printing and Publishing Co., Ltd., n.d.) Price 4*s*. 6*d*. net.

THIS book is a more elaborated presentation of the views as to the nature of æther set forth by the author in a pamphlet published in 1898. The æther is "regarded as possessing properties such as might justify its being described as a gaseous fluid, composed of atoms almost indefinitely small as compared with recognised chemical atoms." Again, "Æther is a fluid whose ultimate particles, or atoms, are so small that they pass into the minute crevices of spaces in the most solid bodies." This view has much in common with some of the older theories of the æther, and is almost identical with that proposed by Mendeléeff in his tract, "An Attempt towards a Chemical Conception of the Æther" (1902), and which is referred to by the author in support of his views. No attempt is made to overcome the objection first urged by Maxwell to any theory as to the nature of the æther which postulates a discrete structure for it—that all the energy of the universe would have been transferred to it—and the same objection applies even if the æther is regarded as a limiting case of a medium possessing such a structure.

The theory proposed by the author cannot, therefore, be accepted as an ultimate theory of the æther. There remains the question whether this idea of the æther affords a satisfactory working model which could be used to give a concrete representation of physical and chemical phenomena, and enable their course to be definitely followed. The theory is applied to a wide range of phenomena, including gravitation, chemical changes and reactions, heat, light, electricity and magnetism. Many of the explanations that are claimed as consequences of the particular theory would follow from any theory of the æther that assigns to it the fundamental properties of a moving system. The reasoning is in general vague, and the argument is never pushed far enough to enable a quantitative comparison to be made. A few examples will suffice to show the character of the reasoning. On p. 3 the following argument is given:—

"The solar system appears to move through space, borne along in an enormous volume of swiftly flowing æther. Now the resistance offered to the free flow of the æther by the partially impervious bodies floating in it is evidently greatest in the line of greatest thickness of each body, and less as the thickness becomes diminished. Accordingly a difference of momentum is thereby caused in the mass of æther, dashing against the body, and there results a current in the æther from places of higher momentum to places where the momentum is lower, with the effect that a whirl, such as occurs in the air under similar circumstances, is produced. These whirls, then, by their continual action, make the bodies more or less spherical, and set them rotating, each on its largest axis, while the whirls, spreading out in ever widening circles, influence the movements of other bodies floating in the same medium." "In this way, the movements and mutual influence of the heavenly bodies may be explained, in a perfectly rational manner, and without imagining any occult power of attraction."

The reasoning here appears to be scarcely conclusive; there is some unexpressed assumption as to the nature of the action between æther and matter; and that whirls (by which some kind of vortex motion appears to be meant) would necessarily result wants demonstration. These whirls have, at a later stage in the book, to do duty in explaining terrestrial magnetism as well as the relations of the heavenly bodies and their gravitational attraction. Again, p. 11:—

"It has long ago been proved that in æther all bodies fall with equal rapidity towards the centre of the earth, and it may, therefore, be reasonably assumed that all atoms which displace equal amounts of æther have equal weight. There are, however, many and convincing reasons for believing that the atoms of different chemical elements have widely different weights." "The explanation, then, which suggests itself as accounting for this difference, according to the present theory, is the very simple one that the heavier atom is of larger bulk, and displaces more æther than the smaller atom. From this it follows that the sizes of chemical atoms are in the same ratio as their weights."

From this, Gay-Lussac's law and Avogadro's law are derived. Boyle's law and the deviations from it are treated much in the same fashion, and the author then finds it necessary to introduce another factor (p. 15), the *shape* of the molecules. A table of the chemical elements arranged with their atomic weights in ascending order of magnitude (the character—gas, liquid or solid—of each being stated) is given. Arguing from this table, the statement is made:—

"It must hence be admitted that elements with a low atomic weight are much more disposed to be gaseous than those of higher atomic weight, at ordinary temperature and pressure. This quite accords with the theory that their ultimate particles are smaller than those of elements with higher atomic weights."

The difficulty that there are so many solid elements of low atomic weight is got over by invoking the influence of shape. For example, the liquidity of mercury is explained by supposing the atom of mercury to be spherical. A curious reader might wish to know the approximate shapes of the atoms of argon or lithium, but on this point the author is silent. After some pages of the same kind of reasoning, two laws are enunciated: —

(1) "The condition of chemical elements or of chemical compounds, at similar temperature and pressure and under similar conditions generally, depends on their atomic or molecular weights (that is, on the size of their atoms or molecules) and on the shape of their atoms or molecules." (2) "The relative chemical activity and chemical properties of chemical elements or chemical compounds, at similar temperature and pressure and under similar conditions generally, depends on their atomic or molecular weights and on the shape of their atoms or molecules."

The term law appears to be used here in a somewhat unusual sense, as these statements do not constitute laws; to make them such, the laws of dependence should be known. Another good example of the author's mode of reasoning is to be found on pp. 53, 54, where the fact that glass is transparent to light but opaque to heat is explained by the peculiarities of the interstices filled with æther in the case of glass, the nature of these being inferred from the way in which glass fractures.

It will appear from these examples of the author's treatment that his theory cannot even make good a claim to be considered a reasonable working model. A great number, however, of the better known physical and chemical phenomena are brought together, and on this account the book may perhaps prove interesting to readers who have not sufficient leisure or inclination for the perusal of treatises and memoirs that have greater pretensions to scientific accuracy.

FOUNDRY PRACTICE.

General Foundry Practice. By A. McWilliam and P. Longmuir. Pp. vii+383. (London: Charles Griffin and Co., Ltd., 1907.) Price 15*s*. net.

THE opinion is generally held among metallurgists that with the rapid progress made of recent years in Great Britain in the metallurgy of iron the foundry has hardly kept pace. Mr. McWilliam and Mr. Longmuir take a more optimistic view, and believe that advances have been, and are being, made of a magnitude commensurate with those of other industries. Certainly signs of progress are apparent in this important branch of metallurgy. The empirical method of charging the cupola is giving place to the system of weighing all materials in proportions determined by the chemist. High-temperature measurement is being practised in the core and drying stove. The field for machine moulding is extending. Permanent moulds made of carbon or similar material are being tried; and the founder is just realising the fact that micrographic analysis has a commercial value. In short, in all branches of his work he is showing a praiseworthy desire to emerge from the slipshod ways of the past. The literature of the subject has, however, remained meagre, and not of a strikingly scientific character. Scattered through the pages of the Journal of the Iron and Steel Institute and of the iron trade journals there is much information of permanent value; but the special treatises on the subject are mostly of an elementary character. The exhaustive work by Mr. McWilliam and Mr. Longmuir may therefore fairly be regarded as marking an epoch in the history of iron founding, and should help greatly in effecting a clear understanding of the subject. The authors possess special qualifications for the work they have undertaken. Mr. Longmuir has held the position of foundry foreman, and is a Carnegie research medallist of the Iron and Steel Institute, while Mr. McWilliam, a distinguished Associate of the Royal School of Mines, has at the University of Sheffield had ample opportunity of ascertaining the needs of students. They have therefore been able to draw upon experience gained under normal foundry conditions and under the conditions of experimental laboratories, and the operations they describe have been personally followed.